REMARKS

Claims 7, 8, 12-17 and 20-28, all the claims pending in the application, stand rejected. Claims 7, 8, 12, 13, 17, 26 and 28 are amended.

The focus of the claims, as now seen in independent method claims 7, 12, 26 and 28, is on (1) the combination of steps in the overall process and (2) the specific parameters involved in each step and the characteristics of the article resulting from each step.

The amendments to claims 7 and 12 that add limitations to the precision polishing step are supported at least by the original disclosure at paragraph [0137] of the published specification. The amendments that add limitations to the etching step are supported at least by the original disclosure at paragraphs [0106], [0122] and [0147] of the published specification and claim 17. The amendments that add a cleaning step are taken from claims 8 and 13, and the further limitations as to flatness of the main surface after cleaning are supported at least by paragraphs [0101], [0156] and [0162] of the published specification.

The amendments to claim 8 that defined the limitations on the amounts removed during the cleaning step are taken from claim 15.

The amendments to claims 26 and 28 find support similar to those made for claims 7 and 12. The limitation to the width of the crack being found at least at paragraph [0122].

Information Disclosure Statement

The Examiner continues to maintain that the Information Disclosure statement filed October 11, 2007 fails to comply with 37 CFR 1.98(a)(1) because it does not include (1) a list of all patents, publications, applications, or other information submitted for consideration by the Office; (2) U.S. patents and U.S. patent application publications listed in a section separately from citations of other documents; (3) the application number of the application in which the information disclosure statement is being submitted on each page of the list; (4) a column that provides a blank space next to each document to be considered, for the examiner's initials; and (5) a heading that clearly indicates that the list is an information disclosure statement.

In order to overcome this objection, Applicants are resubmitting the Information Disclosure Statement. The Examiner's review and acceptance of this Statement is respectfully requested.

Claim Rejections - 35 USC § 112

Claim 28 is rejected under 35 U.S.C. 112, first paragraph, as failing to comply with the written description requirement. This rejection is traversed fore at least the following reasons.

The Examiner asserts that several limitations in newly added claim 28 do not have support in the specification. Applicants have identified below the support for the original language or the language as amended by the present response.

The limitation requiring a step of "carrying out a precision polishing step on the main surface of the glass surface with a predetermined polishing-off amount" is supported by the disclosure at paragraphs [0043], [0128]-[0134], [0138] and [0149].

The limitation requiring that the inspecting step is "carried out by monitoring the main surface mirror-finished by the precision polishing step" has been modified to refer to the adverb "inspecting," as supported by paragraphs [0043], [0128]-[0134], and [0138].

The limitation requiring a determination wherein a defect is "located in a position deeper than the predetermined polishing-off amount" is supported by paragraphs [0043], [0128]-[0134], and [0138].

Claim 28 is rejected under 35 U.S.C. 112, second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which applicant regards as the invention. This rejection is traversed for at least the following reasons.

The Examiner asserts that the precise metes and bounds of the claimed invention are unclear and indefinite with respect to the inspecting step which is "carried out by monitoring the main surface mirror-finished by the precision polishing step and the defect that is located in a position deeper than the predetermined polishing-off amount and that is elicited by the precision [polishing] step."

Applicants have amended this limitation to recite that the inspecting step is "carried out by ~~monitoring~~ inspecting the main surface mirror-finished by the precision polishing step and the defect that is located in a position deeper than the predetermined polishing-off amount and that is elicited by the etching step and remains after the precision polishing step." Support for this limitation may be found at paragraph [0043], [0128]-[0134], and [0138] of the published application and in Figs. 3-5.

Claim Rejections – 35 USC § 103

Claims 7, 8, 12-17, and 20-28 are rejected under 35 U.S.C. 103(a) as being unpatentable over Walker (US 2,372,536) in view of Feng (US 6,596,042 B1) and Hagihara (US 2001/0051746 Al). This rejection is traversed for at least the following reasons.

The Invention

The invention expressly concerns a specific combination of steps that define a method of producing a ***glass substrate for a mask blank,*** which mask blank is used to produce an electronic device according to current-day submicron technology. The current art involved in producing glass substrates, as of the effective filing date of the above-referenced application, is highly sophisticated, and minor changes in any given step can dramatically affect the quality of the ultimate glass substrate product. The several steps combined together, and not individually, are effective to solve modern problems involving the manufacture of high quality glass substrates for mask blanks.

Specifically, as recited in the claims, the invention involves the following steps in the manufacture of a glass substrate:

(1) etching, prior to a precision polishing step, the main surface of the glass substrate (1) to remove between 0.01-0.20μm of glass from the main surface and (2) to increase a size of a crack which extends from the main surface of the glass substrate in the direction of the depth and which might remain on the surface of the glass substrate even after the precision polishing step,

(2) carrying out a precision polishing step for polishing the main surface of the glass substrate so that a predetermined amount of the glass is removed from the main surface, resulting in the main surface having a roughness of 0.2nm or less in terms of the root mean square roughness (RMS), and

(3) carrying out a cleaning step after the precision polishing step whereby flatness of the main surface is 1μm or less;

wherein the etching step is executed on the condition that a polishing-off amount is reduced in the precision polishing step so that a resultant amount of a turned-down edge of the glass substrate falls within a range between -2μ m and 0μm after the precision polishing step.

The requirements for manufacturing a modern glass substrate involve a consideration of each step in the manufacturing process, from initial lapping and grinding, to coarse and fine polishing, as each step has the potential to damage the substrate or be ineffective in removing small defects that can affect the utility of the product as a mask blank for semiconductor manufacturing at a submicron level. The parameters stated in the claims are critical to achieving a quality product useful as a mask blank for submicron applications. Those parameters and the steps in the process are significantly different from and more precise than those used in glass lens manufacturing.

As is known in the art and as explained at paragraphs[0016]-[0020] and [0025] of the published specification, such glass substrates must be flat and are subject to severe requirements for transparency and smoothness, so that light at extremely short wavelengths can pass through the resulting mask and accurately form structures with sub-micron dimensions. Particular problems arise with cracks and other defects that will affect the utility and reliability of the mask blanks. Because of the delicate nature of the glass substrate, the conventional glass handling techniques, treatment processes and equipment that are used for visual or photographic lens manufacture cannot apply and would not be referenced or relied upon by one skilled in the glass substrate manufacturing art in 2003.

The invention, as disclosed through several examples in the original specification, emphasizes the strict dimensional tolerances that must be observed when processing a glass substrate for use as a mask blank. Because of the restricted dimensions of the glass substrate, the amount of material that can be removed in each of several steps is tightly restricted, yet the resultant product must have a highly accurate polished finish. Initial lapping, grinding and rough polishing steps produce an intermediate product, but that product may have minute cracks or latent defects that ultimately must be removed or identified so that there is confidence in the

accuracy of the mask blank for subsequent application in a manufacturing process. Additional polishing and etching steps are used in conventional substrate production processes, but these steps result in roughened or concave surfaces that are not suitable to meet modern electronic device manufacturing requirements, as explained at paragraphs [0023]-[0024] of the published specification. In general, the conventional glass substrate production processes are superior to conventional visual or photographic lens manufacturing processes, yet still are unable to provide the accuracy and yield demanded by electronic product specifications in 2003.

A Combination of Precise Steps

As noted above, the achievement of a high quality glass substrate suitable for current-day semiconductor manufacture in 2003 requires a sequence of several individual precision steps, the output of previous steps directly affecting the quality of the output of subsequent steps. According to the present invention, following a rough polishing step, a precision etching step is followed by a precision polishing step and, thereafter, a precision cleaning step.

The amended claims define the parameters of each of these steps, which must be followed in the stated sequence in order to achieve the high quality product with high yield demanded in current semiconductor manufacturing processes.

Trade-Offs for Precision Polishing

The present invention applies a precision polishing step to the delicate substrate, the recited step being strictly limited as to the amount of material removed and, thus, limited as to the ability to produce a desired smoothness to a roughened surface. Specifically, in the precision polishing step (1) a predetermined amount of the glass is removed and (2) the main surface is given a roughness of 0.2nm or less in terms of the root mean square roughness (RMS). This fine polishing step alone is not effective to provide a desired output and yield, but must be combined in a particular order with additional steps.

For example, as explained at paragraph [0023], the precision polishing step cannot remove scratches that are deeper than 1.0μm within a reasonable production cycle. Also, even if the precision polishing step is applied for an extended period, larger turned down edges will

result. Finally, the use of an etching process after precision polishing will be ineffective, as explained at paragraph [0024] of the original published specification.

Thus, the precision polishing step must trade off the ability to remove deep scratches or defects against the ability to provide (1) a smooth surface with low roughness and (2) small turned down edges, so that the substrate can be securely loaded on a stepper of an exposure machine that produces submicron features, within an overall process that has a desired high productivity. That overall process adds an etching step prior to the precision polishing step so that the high yield can be attained.

Use of Etching To Attack Glass And Identify Defects

In an etching step, according to the disclosure in the present application, the main surface has between 0.01-0.20μm of glass removed and a size of any remaining defect is expanded and becomes at least .2 microns in width so that it is visible. The etching is not simply a cleaning step to remove debris, but it is intended to widen scratches or defects that will not be removed by precision polishing because of its shallow reach (see paragraph [0091] of the published specification). The claims have been amended to emphasize that precise function. In this regard, the etchant is selected to attack the glass of the substrate (see paragraph [0021]-[0024] of the published specification). The etchant is not focused on dissolving the polishing materials, as that function is left for a cleaning step.

Final Cleaning to Preserve Smoothness and Edge Definition

A cleaning step for cleaning the main surface after the precision polishing step is conducted to clean away debris that remains after polishing. It is designed to minimize removal of glass, i.e., no more than 0.01 μm of glass material, and thereby preserve the amount of a turned-down edge of the glass substrate, so that the edge falls within a range between -2μm and 0μm after the precision polishing step. The importance of preserving the turned down edge within the recited parameters is explained at paragraph [0123] of the present application.

Combination of Steps Improve Over Prior Art

The patent to Walker is representative of old conventional lens technology that is incapable of solving the problems confronted in the preparation of glass substrates for mask

blanks. The techniques in Walker would not be considered by one skilled in the glass substrate manufacturing arts as a basis for a solution to a surface quality problem. Walker applies to different products, and uses the various polishing and etching steps for different purposes and in different orders from the present invention. The deficiencies of Walker are detailed subsequently.

(I). Walker (2,372,536):

Initially, as is clear from the face of the Walker patent, it must be noted that the reference was issued in 1945, more than 50 years prior to the making of the glass substrate production method that is disclosed and claimed in the above referenced application, and represents old glass processing technology, in particular, glass object finishing technology for glass objects that transmit light at long wavelengths. The extent (depth, width, length) of glass materials that could be affected by polishing and etching processes of that day could not have the precision needed for production of mask blank substrates of today. Moreover, there were no instruments available to measure, and thereby control, the accuracy of the results,. Also, the concept of a "flatness" that is measurable by a laser did not exist in 1945 as the laser had not yet been developed. Finally, the nature of the defects, such as scratches, that would be of concern to lenses and other objects having a large volume or mass in the era of 1945 would not be expected in and would not be applicable to modern thin and fragile materials that are to be used in products demanding high optical accuracy in the submicron range.

Thus, the broad generalizations in Walker with respect to what to try or what to do with respect to the finishing of visible light-transparent objects would have no meaningful teaching to one skilled in the art. Even if arguably relevant, those approaches would be viewed by one skilled in the art as having significant practical limitations that would mitigate against use for the highly precise glass substrate products to which the present invention is directed.

<u>Walker Has No Focus on Widening Scratches</u>

The Walker patent does not rely upon etching to identify scratches by widening them. Walker is concerned with making the defects "readily discernable" but uses an etch to dislodge and remove "debris matter of the earlier grinding operation." The reaction "continues for such length of time as may be necessary to provide the complete clearing away of the debris referred

to." This includes the abrasive or rouge used in polishing and crystallized glass grains. There is no teaching that a scratch will be made larger to make it more visible by etching the glass. Indeed, even if a layer of the entire surface of the glass is etched away, the width of the scratch would become smaller. There also is no teaching or suggestion that the etching step will remove the surface by an amount only between 0.01 and 0.2 microns.

In fact, the present application is the first to teach in paragraph [0106] of the published application that "an amount of etching below 0.01 μm is not desirable, because it would make it difficult to determine the presence of a crack in the defect inspection step carried out after the precision polishing step. On the other hand, an amount of etching over 0.2 μm is not desirable, either, because the surface roughness and the surface configuration (flatness) would deteriorate as a result of the etching of the glass substrate."

Walker Has No Concern With Flatness and Edge Definition

The Walker patent is not concerned with flatness, in part because it primarily teaches the manufacture of curved lenses. Even though "flats" are mentioned briefly by Walker, the disclosed process would not be applicable to flat substrates for mask blank applications because Walker intentionally attempts to "round off the cusp structure to low dome form." To one skilled in the art, this demonstrates that Walker could not be contemplating a goal of having a roughness of 0.2 or less RMS, as now claimed. In addition, Walker is willing to accept a surface with a dome form, which would be acceptable in lens manufacture; however, such surface would not be acceptable in the manufacture of glass substrates for use as mask blanks because it would affect both the flatness of the substrate and the profile of its edges.

Routine Experimentation In Lens Technology Would Not Lead to Mask Blank Technology

The Examiner's strong reliance on "routine experimentation and optimization" as a basis for achieving the process taught by us is misplaced in framing a rejection of claims directed to Applicants' method for producing a glass substrate for a mask blank on the basis of lens technology. First, the products, the technical challenges, and the practical manufacturing processes are significantly different. Second, when faced with the problem confronted by us, one skilled in the art would not look to visible light transparent lens technology for a solution,

and in fact, would reject such technologies as not being relevant because of the distortion it would provide to light at short wavelengths. Third, the results derived from using the claimed process would be unexpected with respect to the limited plans for the Walker process.

<u>The Results Demanded and the Underlying Processes Are Significantly Different</u>

The teachings of Walker for lenses and other stock objects would not be considered by one skilled in the art to be directed to or even relevant for the manufacture of thin glass substrates. First, glass substrates demand exceptionally high quality, especially with respect to the flatness and smoothness of their main surfaces, for use as a mask in the manufacture of electronic devices. Because of the short wavelength laser light that is used in such manufacture, distortion cannot be tolerated. Walker, on the other hand does not, and in 1945 would not, be concerned with short wavelength light distortion. The focus is on visible light at long wavelengths. Second, as a result of the different goals and required results, the processes are necessarily different, especially with respect to the accuracy and tolerances of each step and the resulting product.

<u>Walker's Etching Process</u>

Following a rough grinding step, Walker subjects the stock piece to immersion in a reactive chemical agent or etching solution which simultaneously removes the surface debris particles and rounds off the edges of the stockpiece. Although Walker discloses that after the etching treatment, "any relatively deep surface scratches or other mars will now be readily discernible," the disclosed etching process would not be applicable to or even suggest modification for glass substrates for at least three reasons.

First, the result of the etching step as taught by Walker is a surface that comprises a series of relatively low domes or wave-like formations, as illustrated in Fig. 4 and taught at page 3, col. 2, lines 14-26. After subsequent polishing, the surface would have a "regular formation," as illustrated in Fig. 5. However, even though no dimensions are given in Walker, based upon the vintage of the teachings, the domes that exist following the etching step and the surface with a "regular formation" that exists following the polishing step, would have a size and characteristic commensurate with large stock pieces and not with glass substrates that are for electronic device manufacture. Accordingly, the disclosed process in Walker would not be considered applicable

to the manufacture of a glass substrate because an etch that forms relatively large low domes or leaves waves on a surface would not be acceptable.

In order to emphasize this feature, the claims have been amended to specify the amount of material removed by the etching process is between 0.01-0.20μm of glass.

The Examiner previously observed that in Walker the "etch rate of the etchant or cleaning solutions may be controlled by tailoring the ratio of solution constituent hydrofluoric and sulfuric acids, the substrate immersion time, and the bath temperature (Page 3, Column 1, line 44 through Column 2, line 26)." The Examiner also admits that Walker is silent regarding the amount of material removed from either the etching step or the final cleaning step. The Examiner asserts that such amounts would have been obvious. However, consistent with the teachings in the present application at paragraph [0024] with regard to the acids used in etching or cleaning processes, the amount of removal by chemical etching is 0.2 to 0.5 μm, so that the surfaces of silica glass substrates are roughened, even if there are no concave defects. The teachings in Walker, as understood according to the practices in the conventional substrate production arts, would result in such undesirable roughening and would deter consideration of Walker's technology for the production of high quality glass substrates.

Second, the etching step in Walker is concerned with loosening debris so that scratches that are filled with the debris can become visible. There is no teaching that the etch is to widen scratches that are deeper than an amount to be removed by fine polishing. The claims have been amended to expressly state the feature of widening the existing scratches on the substrate surface.

Third, the nature and intensity of the etch solutions taught in Walker would result in undesirably rounded edges of the glass substrate, so that after precision polishing, they would not fall within the range of -2microns and 0 microns as now claimed.

Walker's Polishing Process

The Examiner observes that the etched stockpiece in Walker is further subject to a fine polishing or precision polishing, with reference to page 3, column 2, Lines 45-46. Applicants respectfully submit that there is no teaching as to the amount of material removed from the

stockpiece. However, in further defining the claimed method with the precision reflective of a production of a high quality glass substrate for a mask blank, <u>the claims now specify that the roughness of 0.2nm or less of the main surface is obtained</u>, for example, by controlling the amount of removed material within limits of no more than 1.0μm.

<u>Walker's Cleaning Process</u>

The Examiner notes that after Walker's fine polishing step, the substrate is optionally subjected to a final dip or "cleaning step" in an etchant solution or chemical debris-clearing solution, with reference to page 5, col. 1, lines 17-38. However, as now claimed, the cleaning step is carried out after the precision polishing step <u>whereby flatness of the main surface is 1μm or less</u>. The cleaning treatment as taught by Walker in 1945 would not be able to produce the high quality surface with the recited flatness. Further, there clearly is no hint that Walker even contemplated that the recited flatness could be achieved. The Examiner asserts that it would have been well within the purview of one of ordinary skill in the art at the time of the invention to provide a cleaning step etch of between 0 to 10nm depth and to likewise control the etch rate to within the claimed ranges of between 0.2nm/min and 2 nm/min based on the generic statements in Walker with regard to factors affecting etch rate and etch depth, such as etchant concentration, immersion time, and bath temperature. These generic statements as applied to large stock pieces would not be viewed as relevant teachings by one skilled in the glass substrate art that would give meaningful direction and guidance for routine experimentation and optimization. The environment of the overall method and the combination of individual steps as claimed yield unexpected results, that one of ordinary skill in the art at the time of the invention would not have considered achievable on the basis of the processes and products in Walker.

(II.) Feng (US 6,596,042 B1);

The reference to Feng is cited for its teaching of "common techniques, materials, and tolerances considered to be known to skilled practitioners in the field of precision polishing or Chemical-Mechanical polishing (CMP)."

Feng is cited for its teaching of particular polishing materials and polishing operations which use colloidal silica and/or cerium oxide abrasive particles. However, Feng does not provide guidance to one skilled in the art with respect to the application of teachings from a lens

product manufacturing process as in Walker to a high precision glass substrate product. In particular, not only does Feng fail to teach the recited parameters for even a single step of the recited method, Feng fails to teach the goals that would lead to the modification of the several individual steps and their combination into a complete method, as claimed.

(III.) Hagihara (US 2001/0051746 Al)

The Examiner cites the reference to Hagihara for its teachings relative to a method for precision polishing a substrate which provides a minimum "roll-off' (edge rounding of end sides of the substrate) in the polishing process. The Examiner states that the process termed as "roll-off' in Hagihara is equivalent to the claimed "amount of a turned-down edge" of a substrate.

In fact, the latter term is defined at paragraph [0069] of the published specification for the above referenced application where it is stated that:

> **The turned-down edge amount is defined by the maximum height in the distance range of 3 mm from the boundary between the main surface and the chamfered surface when a virtual reference surface that extends 3 to 16 mm toward the center from the boundary between the main surface and the chamfered surface of the glass substrate is provided, and the height of the virtual reference surface is defined as 0, as shown in FIG. 2. Here, a negative (-) maximum height means that the peripheral portion of the main surface of the substrate has a turned-down configuration (a turned-down edge configuration), while a positive (+) maximum height means that the peripheral portion of the main surface of the substrate has a protuberant configuration.**

Hagihara on the other hand discloses the “roll off” at paragraph [0011] as a rounding of an end part of a substrate to be used for a hard disk drive. The hard disk is preferably made of <u>metal</u>, because roll off can be made small, as taught at page 4, paragraph [0063]. The reference teaches the use of a ”roll-off reducing agent selected from certain compounds, as summarized at paragraphs [0012]-[0032]. Although brief mention is made of other substrate materials such as glass and ceramics, the <u>preference clearly is for metals</u> used for magnetic disk substrates (paragraph [0065]). The Examiner asserts that the achievement of a reduced roll off increases the data recording area and subsequently leads to higher hard drive capacities, and notes that a particular polishing agent can result in certain roll off values. However, the data relates to the

preferred metal medium and provides no specific teaching with regard to glass substrates, especially those used for mask blanks.

The teachings of Hagihara are focused on metal substrates for disks and, notwithstanding the brief mention of general applicability to glass substrates, would not lead one skilled in the art to consider applying the teachings of Hagihara to modify Walker to achieve the polishing steps and the overall process defined by the claims. While the Examiner argues that the "turned-down" amount appears to be conventional tolerance in the art with respect to optical disk substrates, Applicant now has demonstrated that the specific teachings with respect to metal substrates do not translate to specific teachings for glass substrates, primarily because the mention of glass as a substrate material brief, generic and non-specific.

Thus, having a "turned-down edge" of a glass substrate fall within the claimed range of -2.0μm to 0μm after a precision polishing would not be "routine" because, on the basis of then current technology in 1945 and the differences between metal and glass materials, edges on glass substrates within the recited range could not be obtained.

In sum, Applicants have provided through claim amendment a specific definition of the invention as applied to a glass substrate for a mask blank. Applicant's submit that their arguments fully comply with 37 CFR 1.111(b) because they provide specific assertions that clearly demonstrate that the language of the claims patentably distinguishes them from the references.

In view of the above, reconsideration and allowance of this application are now believed to be in order, and such actions are hereby solicited. If any points remain in issue which the Examiner feels may be best resolved through a personal or telephone interview, the Examiner is kindly requested to contact the undersigned at the telephone number listed below.

The USPTO is directed and authorized to charge all required fees, except for the Issue Fee and the Publication Fee, to Deposit Account No. 19-4880. Please also credit any overpayments to said Deposit Account.

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